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[ETD 11: Secondary Cells and Batteries]

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Indian Standard

SILVER OXIDE ZINC BATTERIES FOR AIRCRAFT — SPECIFICATION

UDC 621·355·84 : 629·73·064·52

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1992 **Price Group 6**

Secondary Cells and Batteries Sectional Committee, ETD 11

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Secondary Cells and Batteries Sectional Committee had been approved by the Electrotechnical Division Council.

This specification lays down the general requirements for silver oxide zinc alkaline battery 22·5V 45 AH at 1 hour rate.

The battery is suitable for airborne use as a main aircraft battery and has the capability for cranking (starting) the aircraft on ground. In the preparation of this specification, necessary assistance has been derived from the following specification:

a) HAL Nasik Specification TS/IND/72/17 A/C Storage battery 15–STS–45B and 15–SSTS–45B

b) JSS 55555 Environmental test methods for electronics/electrical equipments and

c) DEF–35 General specification for portable secondary batteries.

For the purpose of deciding whether a particular requirements of this standard is complied with, the final value, observed or calculated, expressing the result of a test shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SILVER OXIDE ZINC BATTERIES FOR AIRCRAFT — SPECIFICATION

1 SCOPE

This specification covers the general design and test procedure for silver oxide zinc alkaline battery 22·5 V, 45 AH at 1 hour rate for use in combat aircraft. The specification may be altered for use in other types of aircraft including rotor craft by inclusion/exclusion of clauses applicable to those aircrafts/rotor crafts.

2 REFERENCES

The following Standards are necessary adjunct to this Standard:

IS No.	*Title*
613 : 1984	Copper rods and bars for electrical purposes (*second revision*)
1146 : 1981	Rubber and plastic containers for lead-acid storage batteries
1885 (Part 8) : 1986	Electrotechnical vocabulary : Part 8 Secondary cells and batteries

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 1885 (Part 8) : 1986 in addition to the following shall apply.

3.1 Type Test

Tests carried out to prove conformity of the design and quality of the product to the requirement of the specification.

3.2 Acceptance Test

Tests carried out on production samples selected at random by the Quality Assurance Authority to ensure conformance of the design and quality of the product to the requirements of this specification.

3.3 Routine Test

Test carried out in all batteries to check conformance to the requirements of the specification.

4 MATERIALS

4.1 All materials used shall be of the highest quality for the particular duties and shall conform to the relevant specification unless otherwise specified.

4.2 Plastic Materials and Parts

The cell containers shall be made of strong alkali resistant materials and should preferably be made of Polyimides (Nylon). Unmachined plastic materials and parts shall have the original smooth or polished surfaces. Surfaces that have been sawed, cut, punched or otherwise machined shall be as smooth as practicable in accordance with good manufacturing practice for the intended application. These should conform in general to IS 1146 : 1981.

4.3 Rubber Components

These shall conform to **A-3**.

4.4 Battery Container

The battery container shall be made of high strength rustless stainless steel material conforming to IS 1146 : 1981. It shall be manufactured as per approved drawings and shall have a smooth finish, free from pitting, blow holes, scale, blisters or other deformations.

4.4.1 The battery container shall be finished appropriately with a coating of lacquer.

4.4.2 The lid and body of the container shall be provided with a suitable alkaline resistant insulating sheet of adequate size and thickness such as a PTPE lining to ensure high insulation resistance between the cell terminals and the container body.

4.5 Inter Cell Connectors

The intercell connectors shall be of copper as per IS 613 : 1984 and silver plated to the required thickness. They shall have sufficient cross sectional area to withstand charge or discharge rate specified in the specification. The connectors shall not obstruct the filling apparatus of the battery and shall be suitably dimpled at the centre to facilitate voltage measurement of individual cells.

4.6 Positive and Negative Plates

The plates shall be of such design as to retain the active material securely under all conditions of service use or storage specified in the specification. The plates shall permit free access by the electrolyte and shall be of the number, thickness, size and weight necessary to ensure compliance with the specified performance requirements. The current density on plates shall not exceed 750 Amps.

4.7 Separators

The separator material shall be such that to ensure specified performance of the battery under all conditions of service/storage called for in the specification. The separator and other internal insulation shall be so dimensioned that they ensure maximum protection against short circuiting of the plates. The separators shall be of such material so as to permit excellent wetting by strong potassium hydroxide.

4.8 Terminals

The terminals should be silver plated and of adequate cross sectional area to withstand without any undue overheating the prescribed rate of charge/discharge called for in this specification.

4.9 Cell Covers

The cover of each cell shall be homogeneously cemented to the case by a suitable sealing/cementing compound to make it fully leak proof. Pressure heat sealing should be adopted without damage to the internal parts or components.

4.9.1 *Vent Plugs*

Vent plugs shall be of approved material and construction shall be such that the battery satisfies the electrolyte spillage test requirements of the specification. Sealing washers for vent plugs shall be alkali resistant material and shall satisfy the requirements of **A-3**.

4.9.2 *Latches and Handles*

Latches and handles shall be of approved material and construction. The dimensions shall be as specified in the approved drawings.

4.9.3 *Bolts and Nuts*

Bolts and nuts shall be of approved material and construction shall conform to the approved drawings by the purchaser as regards to dimensions. The bolts and nuts that come in the electrical connections shall be silver plated to suitable thickness and the others shall have adequate protective finish to withstand the relevant environmental conditions as called for in this specification.

4.9.4 *Gas Escape Valve*

The gas escape valve shall be calibrated to operate within 0·3 to 1·0 kg/cm^2 pressure.

4.9.5 *Battery*

The battery shall consist of 15 active cells with at least 45 capacity at 1 hour rate 1·5 V and terminal voltage connected in series through intercell connectors. In addition, the battery shall be capable of meeting the requirements on heavy discharge test (Engine Starting Test and Heavy Discharge Test) at $0^\circ + / - 2^\circ$ C. The batteay with the cells connected in series shall be terminated through a dummy cell of adequate design.

4.9.6 *Dummy Cell*

The dummy cell shall be of bakelite cover with a socket at its bottom side and a plug at its top. The socket plug and the current carrying leads of the dummy cell shall be of adequate current carrying capacity and shall not get unduly overheated during the charge/discharge rates called for in this specification.

5 DIMENSIONS

The dimensions of batteries shall be as specified in this specification.

6 GENERAL

6.1 Workmanship and Finish

The battery shall be manufactured in accordance with good design and sound engineering practice.

7 MARKINGS

Each cell shall be marked with the following information:

a) IS reference number,

b) Voltage and AH capacity at 1 hour rate,

c) Government approved mark, that is, broad arrow,

d) Month/Year of manfacture,

e) Serial No.,

f) Indicating the source of the manufacture, and

g) Positive terminal of cell shall be painted with red colour and negative terminal with blue colour.

7.1 In addition, the battery box shall be marked and the plate having the following particular:

a) Nomenclature,

b) Indicating the source of manufacture,

c) Month/Year of manufacture,
d) Manufacturer's type No.,
e) Serial No.,
f) Govt. broad arrow mark, and
g) Reference No.

7.2 Provision shall be made in the battery container by way of adequate window openings so as to facilitate reading of the permissible maximum and minimum electrolyte level of every cell without removing any cell.

7.3 Provision shall also be made for the fitment of suitable vent pipes at the top of the battery container for easy escape of evolved gases and fumes.

7.4 Inter-changeability

Like units, assemblies and replaceable parts shall be physically and functionally interchangeable without modification of such items or the equipment. Individual items shall not be hand picked for fit or performance.

8 SERVICE LIFE OF THE BATTERY

8.1 Service life of the battery should be:

a) 9 months from the moment of filling it with electrolyte including idle time within which initial 6 months with 100 percent capacity and the rest with at least 40 AH

OR

b) 180 flying hours

OR

c) Fully charged battery must be able to provide a minimum of 3 consecutive autonomous starts to aircraft engine at a time with an interval of not less than 3 minutes between starts. This capacity utilization of 3 autonomous starts of fully charged battery shall be available throughout the guaranteed service life except in the last 3 months when it may be relaxed to 2 autonomous starts.

8.2 Operating Conditions

The batteries shall be operated and maintained by the users as per the existing facility and the procedure:

i) The batteries shall be charged initially as per the manufacturer's instruction;
ii) Charged batteries shall be fitted in the A/C, where it shall be on float charges from a constant potential source of 28·5 V ± 0·5 V; and
iii) The battery is intened to operate under the following conditions:
  a) Altitute up to 25 Km, and
  b) Ambient temperature variation from −50°C to + 55°C within the specified altitude.

9 STORAGE LIFE

The batteries when stored in filled or unfilled condition shall give satisfactory performance, throughout the service life period, the period of storage in unfilled condition not exceeding 3 years.

10 TYPE TESTS

The following shall constitute the type tests and shall be carried out on adequate number of prototype samples. The exact number of prototype samples shall be decided by the Design Authority. The tests are to be carried out in the sequence given in **10.1** of this specification.

10.1 Details of the Type Tests

1 Visual examination
2 Dimensions and weight
3 Polarity of plates
4 Absence of short circuit (Applicable to unfilled batteries only)
5 Leak test
6 Insulation resistance test
7 Electrolyte retention and spillage test
8 Capacity discharge test at 5 hour rate
9 Nominal/rated capacity test
10 Heavy rate dicharge test at normal temperature
11 Heavy rate discharge test at 0 ± 2°C
12 Service life test comprising of 35 charge discharge cycles with the following environmental and mechanical tests suitably interposed:
  a) Low temperature test
  b) High temperature test
  c) High altitude test
  d) Self discharge test
  e) Vibration test
13 Acceleration test
14 Impact test
15 Humidity test
16 Corrosion test
17 Storage life (unfilled) test
18 Storage life (filled) test
19 Installation and engine start test
20 Flight test

10.2 Methods of Tests

Methods of tests to be carried out for proving conformity of the item with the requirements of this specification are given below.

10.2.1 *Visual Examination*

In this test the batteries are examined for adequate construction, absence of dusts, cracks, dents, correctness of polarity, tightness of nuts, arrangement of internal connections, provision of vent pipes, lifting handles etc.

10.2.2 *Dimension and Weight*

The dimensions of the battery shall be:

Overall length : 427 ± 1 mm
Overall height : 225 ± 2 mm
Overall width : 130 + 2·5 mm
− 1·5 mm

The weight of the battery with container shall be:

a) in unfilled condition — less than 15·2 kgs
b) in filled condition — less than 17·9 kgs.

10.2.3 *Polarity of Plates*

The polarity of the plates in relation to that of the terminals or intercell connectors to which they are connected will be verified electrically or visually to ensure that the cells are adding each other.

10.2.4 *Absence of Short Circuit (Applicable to Unfilled Batteries only)*

In batteries whose manufacturing process procludes retention of moisture in the casing, when an electrical supply of 120 V dc, in series with a lamp is connected across the terminals of each cell, in turn, the lamp shall not burn, thus proving the absence of short circuit between plates of opposite polarity.

In other batteries whose manufacturing process does not proclude retention of moisture in the cells, a suitable electrical test method to detect presence or otherwise of the internal short circuit will be evolved.

10.2.5 *Leak Test*

The sealing of the batteries will be tested by applying to each cell in turn air at a pressure corresponding to 72 cm of water. The test will be applied with actual vent plugs to be supplied with the battery in position. The internal volume of the pipes, gauge etc between the cell and the air regulating valve shall not exceed 500 cc. The regulating valve will be closed when the specified air pressure is reached. The time for the pressure of the air in the cell to fall from 72 cm to 68 cm of water pressure shall not be less than 15 seconds.

10.2.6 *Insulation Resistance*

Insulation resistance of the battery between its terminals with respect to the container body shall not be less than 20 Mega ohms. The test voltage shall be 500 V dc. Cleaning of the battery top suface is permitted.

10.2.7 *Electrolyte Retention and Spillage Test*

The battery after charging will be subjected to the following tests for electrolyte spillage. During and after these tests, no electrolyte shall spill from the battery or the cells.

TEST A

1) The battery will be tilted through 45° in a plane normal to its major length and so held for 30 seconds.
2) The battery will be tilted through 45° in a plane nomal to its minor length and so held for 30 seconds.

TEST B

1) The battery will be tilted through 60° in a plane normal to its major length and so held for 30 seconds, and
2) The battery will be tilted through 60° in a plane normal to its minor length and so held for 30 seconds.

TEST C

1) The battery will be tilted through 90° in a plane normal to its major length and so held for 30 seconds, and

TEST D

The battery is kept in inverted position for 1 minute.

10.2.8 *Capacity Discharge Test at 5 Hour Rate*

The battery shall be charged at constant current of 4·5 A. The charging will be discontinued when the voltage of any two cells reach 2·1 volts. After giving 24 hours rest, the battery shall be discharged at 9A till the voltage of any one cells falls to 1·2 V. The capacity obtained shall not be less than 45 AH.

10.2.9 *Capacity Discharge Test — Nominal Rated Capacity Test*

The battery after charging as per **10.2.8** and after standing on Open Circuit for 24 hours shall be discharged at 45 A till the voltage of any one cells falls to 1·2 V. The duration obtained shall not be less than 60 minutes.

NOTE — Before commencement of the tests given in **10.2.8** and **10.2.9** the battery shall be subjected to initial forming cycles which includes normal charging, check discharge and additional discharge cycles. The details of these forming cycles will be stipulated by the manufacturer.

10.2.10 *Heavy Rate Discharge Test at Normal Temperature*

The batteries after normal charging and standing on open circuit for 24 hours are discharged in this test through suitable rheostat or equivalent load capable of drawing a peak current of 750 Amps. The battery volt ampere characteristic is shown in Annex B. The batteries are subjected to five discharge of 40 seconds each within between intervals of 3 minutes. During test, voltage and current are noted down. Voltage shall not be less than 16 V at the end of each discharge.

After this discharge the batteries shall stand on open circuit in an ambient temperature of 20 ±5°C for at least 24 hours, after which the residual capacity is to be removed by discharging a 45 Amps to an end voltage of 1·2 V per cell.

10.2.11 *Heavy Rate Discharge Test at* 0° ± 2°*C*

The battery after normal charge shall stand on open circuit in an ambient temperature of 0° ± 2°C for 24 hours. Whilst still in that ambient temperature, it shall be discharged at a constant current of 250 Amps for 2 minutes. The voltage of the battery at the end of 2 minutes with the load still connected shall not be less than 18 V.

After this discharge, the battery shall stand on open circuit in an ambient temperature of 20 ±5°C for at least 24 hours after which the residual capacity is to be removed by discharging at 45 amperes to an end voltage of 1·2 Volts per cell.

10.2.12 *Service Life*

This test included 35 charge/discharge cycles of various types in various conditions. The sequence is given in Annex C. The service life cycles includes the following environmental and mechanical test suitably interposed.

10.2.12.1 *Low temperature test*

This is done after the 10th cycle of charge of the service life cycles. The batteries after charge are kept in cold chamber at −50°C +3°C for three days and later on removed and brought to the temperature of 20°C + 3°C and kept in that temperature for 24 hours. The batteries are then subjected to heavy rate discharge test as per **10.2.10** of this specification.

10.2.12.2 *Self discharge test*

This test is carried out on batteries after the 14th charging cycle of the service life cycles. The batteries are stored in charged condition for 30 days (temperature conditions 20°C to 30°C and 65 percent ± 15 percent RH) and then tested for capacity with discharge current of 45 amperes. The capacity should not be less than 40 AH.

10.2.12.3 *High altitude test*

This test includes two tests carried out after the 15th and 16th charge cycles respectively of the service life cycles.

In the first test the batteries are kept in pressure chamber after carrying out 15th charge cycles as per Annex C (within two hours of charging) and the chamber pressure is adjusted to 19 mm of mercury (corresponding to an altitude of 25 KM) at the rate of 5 KM/min.

After keeping the batteries for five minutes, these are discharged at 45 A for 54 minutes. Discharging is stopped when voltage of any one cell falls to 1·0 volts. After completion of discharge test, the batteries from the chamber are examined for any spillage of electrolyte.

In the second test, the batteries are placed in pressure chamber after the 16th discharge cycle as per Annex C. The pressure is adjusted corresponding to 25 KM at the rate of 5 KM/Min.

The batteries are charged with dc source of 28·5 to 30 V directly and the charge is continued till the charging current becomes less than 3 amperes.

The batteries are removed from the chamber and examined for any spillage of the electrolyte. The batteries shall then be discharged as per **10.2.10**.

10.2.12.4 *Vibration test*

This test includes vibration stability test and vibration resistance test and are carried out after the 21st cycle of charge of the service life cycles.

a) Vibration Stability Test

The batteries charged on 21st cycle are fastened to vibration stand without any dampers and are subjected to vibration from 10 to 200 Hz at multiples of 10 Hz for 1·5 minutes at each frequency. The amplitude of vibration for different frequencies is given in Annex D.

At the end of test the batteries are examined for any spillage of electrolyte or any damage etc.

b) Vibration Resistance Test

Test is carried out on the same batteries which are tested for vibration stability. The batteries are subjected to vibrations at three frequencies as given below:

1) 30 Hz for 9 hours 15 minutes with overload of 2·7 g.
2) 70 Hz for 4 hours with overload of 4·5 g.
3) 200 Hz for 11 hours with overload of 4·5 g. Batteries are then checked for any spillage of electrolyte.

10.2.12.5 *High temperature test*

This test is carried out after the 30th cycle charge of the service life cycle. Batteries charged on the 30th cycle are keept in a hot chamber at 50°C for 2 hours. The batteries whilst still in the hot chamber are discharged at 45 A till the voltage of any one cell falls to 1·0 V. The duration obtained shall not be less than 54 minutes.

10.2.13 *Acceleration Test*

a) The battery shall be normal charged and then subjected in a sequence to the following accelerations:

Forward Acceleration	11·0 g
Backward Acceleration	11·0 g
Side Acceleration	6·5
Upwards Acceleration	6·5
Downward Acceleration	17·5

The side of the batteries containing the hinges is the forward one.

Each loading condition shall be maintained for one minute during which the battery shall supply a load of 40 amperes. The voltage on load shall fall steadily and not fall below 22·5 volts during these tests and battery shall suffer no derangment or damage.

b) Crash Case

The battery shall be subjected to a forward deacceleration of 25 g and a lateral acceleration of 4 g for a period of 1 minute. No damage or derangement shall be produced by loads.

10.2.14 *Impact Test*

The batteries in charged condition should not suffer any mechanical damage or allow electrolyte to spill over when subjected to a total of 10 000 impacts at the rate of 50 impacts per minute under an overload of 4 g.

10.2.15 *Humidity Test*

The charged batteries are placed in humidity chamber for 48 hours at a relative humidity of 95 ± 3 percent and temperature 40°C ± 5°C.

They are later on removed from the chamber and insulation resistance between the negative terminal and the body of the container is measured which should not be less than 2 Mega Ohms.

10.2.16 *Corrosion (Salt) Test*

The corrosion test is to be carried out on the batteries in charged condition.

Check the quality and uniformity of the protective coatings and marks of corrosion, if any, after the test.

10.2.17 *Storage Life Test (Unfilled)*

The batteries are stored for 3 years in unfilled condition at a temperature of the ambient air from −20 to +35°C and RH of 65 ±15 percent in normal position.

After expiry of the storage period, the batteries are brought to working condition and tested for satisfactory performance during the tests listed at **10.2.12**, **12.2.12.1**, **10.2.12.2**, to **10.2.12.4** and **10.2.7**.

10.2.18 *Storage Life Test (Filled)*

Batteries filled with electrolyte, formed but discharged are stored at a temperature from −15 to + 35 degree C with relative humidity of 65 ± 15 percent for a period of six months.

Batteries are given 3 normal charges and then they are again stored for one month in charged condition. Later on the batteries are tested for satisfactory performance during tests listed at **10.2.7**, **10.2.12**, **10.2.12.1** to **10.2.4**.

10.2.19 *Installation and Engine Start Test*

The batteries shall fit into the existing space and location in the type of A/C (Type of aircraft Mig 21, 23, 25 and 27) without requiring any structural or electrical changes to the A/C system. Misalignment, case of removal, fitment etc will be checked.

The batteries are then charged (normally) and fitted in the aircraft. Three consecutive engine starts of 40 seconds duration each and with 3 minutes time in between each start will be given. At the end of each start, the capacity of the battery will be checked with the A/C ampere hour meter and the fall lid capacitor of the battery shall not be more than 15 AH per start. The time taken for the engine to start is also recorded for every start that is attempted and this shall not be more than 40 seconds.

10.2.20 *Flight Test*

To be specified later in co-ordination with Design Authority.

10.2.21 *Failure Criteria*

In case of a failure of a sample in a particular test, double the number of samples called for the test will be retested.

The tests done earlier to the failure will be repeated on new samples.

11 PACKAGING

The stores shall be securely packed to avoid damage during transit so as to reach in perfect, serviceable and fit conditions to consignee.

12 PRODUCTION QUALITY TESTS

12.1 These constitute a range of tests that are carried out on samples selected at random from a production lot to ascertain that the manufacturer conforms to the design and quality requirements stipulated in this specification.

12.1.1 Production quality tests are carried out:

a) Whenever production recommends after a lapse of six months;

b) During the course of continuous production once in every 100 batteries or part thereof produced; and

c) Whenever there is a change in the production process/change in the raw material or sub-assemblies used/or on the introduction of a major modification.

12.1.2 If any of the sample batteries selected for production quality tests fails during the tests, it shall be dismantled for examination and a report on the cause of failure shall be made to the Quality Assurance Authority. Adequate number of fresh samples from the same production lot will be selected and the tests repeated only if these fresh samples pass the tests, the manufacturer shall recommend production and delivery.

12.2 Details of Production Quality Tests

a) Complete range of production routine tests; and

b) Either whole or part of the type tests, the exact number of tests to be decided by the Quality Assurance Authority.

ANNEX A

(*Clause* 4.9.1)

MATERIALS FOR MOULDED CONTAINERS

A-1 GENERAL

Materials shall be such as to form satisfactory mouldings will be proved by tests on representative samples to satisfy the requirements given below. The inspection authority will decide the frequency at which samples selected from production are tested.

A-2 SELECTION, PREPARATION AND TREATMENT OF SAMPLES

a) Tests samples will be cut from containers of the type for the battery. When possible the samples will be cut vertically from the container walls, neglecting strips of 38 mm at the top and bottom of the containers.

b) Samples for tests for impurties extracted by aqueous solutions of potassium hydroxide resistance to attack by potassium hydroxide, solution, and electrical resistance after immersion in potassium hydroxide solution will be 100 mm by 63·5 mm and of the thickness of the container wall. The moulding/skin will not be removed from the uncut surfaces of the samples. The samples will first be washed in cold 10 percent hydrochloric acid for a few seconds only, and then rinsed in cold distilled water until the last traces of acid have been removed. They will then be dipped in boiling water for 10 seconds and the surplus water then removed, first by shaking for about 30 seconds and then by means of filter paper. When dry, and at room temperature, the samples will then be weighed and their dimension measured accurately. They will then individually be immersed in 600 ml of aqueous potassium hydroxide solution of 1·300 0 specified gravity in a covered stainless steel beaker of 800 ml capacity and maintained 60± 2·5°C for 28 days. The level of potassium hydroxide solution will be maintained by the addition of distilled water. At the end of the period the samples will be removed, washed in boiling water for 10 seconds shaken, dried and allowed to cool to room temperature as initially. They will then again be weighed and their dimensions taken accurately. For the purpose of determining the extracted impurities, the volume of potassium hydroxide solution will be measured accurately.

A-3 RESISTANCE TO ATTACK BY ALKALI

a) Samples will be weighed accurately and measured, and their appearance noted, before and after the necessary treatment A-2(b). At the end of the 28 days period the resistance to attack by potassium hydroxide solution shall have been such that:

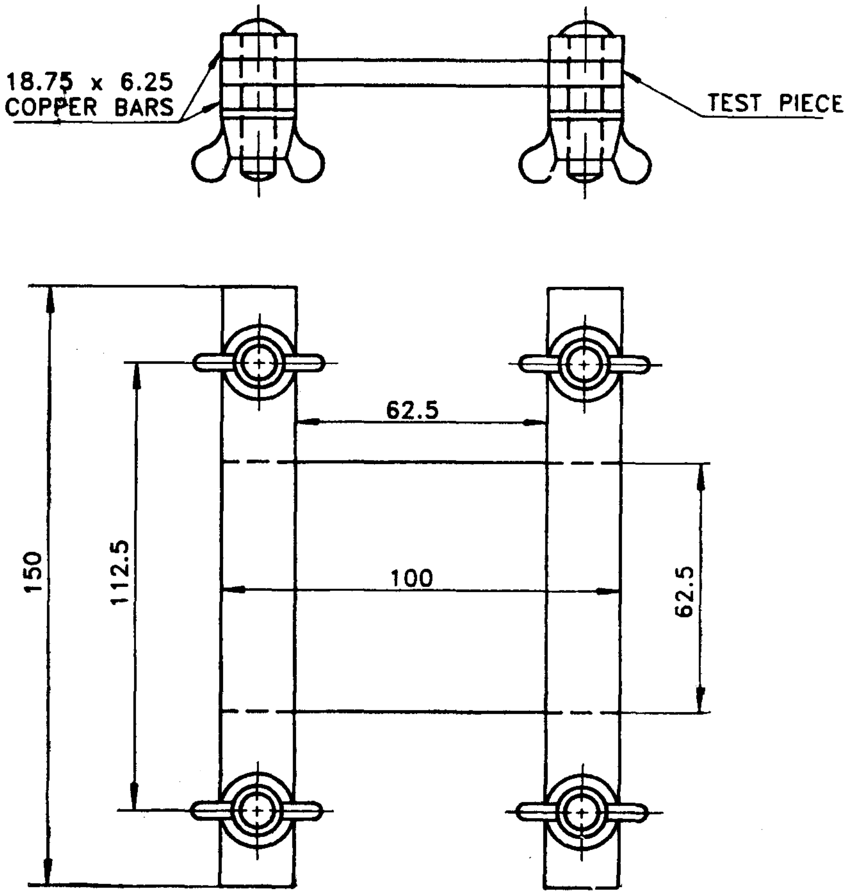
i) The change of weight of samples has not exceeded 1·5 percent,

ii) The change in volume has not exceeded 1·5 percent.

NOTE — It is recognized that the removal of alkali soluble substances may compensate for the absorption of alkali. The change in weight will, therefore, always be considered in relation to the change in volume and appearance.

A-4 ELECTRICAL RESISTANCE AFTER IMMERSION IN ALKALI

A-4.1 The sample will be treated for thirty minutes after the final washing and drying the sample will be clamped between copper bars 19 mm wide by 6 mm thickness of an approx, length of 150 mm, as shown at Fig. 1 of this



All dimensions in millimetres.

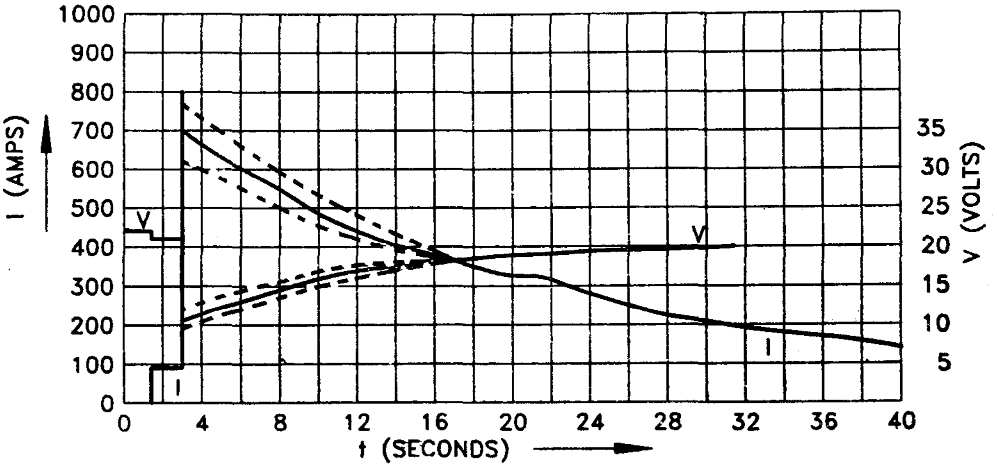
Fig. 1 Electrical Resistance Test

Annex. The copper bars will have been cleaned by means of a scratch brush or emery paper. The bars will be bolted firmly across the shorter 63·5 mm ends of the sample, the edges of the sample being flush with the outer edges of the bars. A potential of 500 volts direct-current will be applied across the clamps and maintained for 30 seconds. The minimum resistance noted during the test period will be recorded. The test will be repeated after 24 hours. The minimum resistance recorded during the two tests will be deemed the resistance of a sample.

A-4.2 The resistance of a sample shall not be less than 500 000 ohms.

ANNEX B

(*Clause* 10.2.10)



HEAVY DUTY DISCHARGE CHARASTERISTIC OF BATTERY

ANNEX C

(*Clauses* 10.2.12 *and* 10.2.12.3)

Programme for Life Test

Charge/Discharge Cycle No.	Type of Charging			Type of Discharging				Remarks
	Normal Charging	Recharging	Direct Charging	54 Minute Rate	5 HR. Rate	Heavy Duty 40 Sec. 5 Times	Heavy Duty 40 Sec. 3 Times	
1	2	3	4	5	6	7	8	9
1	X					X		
2	X				X			
3	X						X	
4			X				X	Electrolyte Spillage
5		X		X				
6	X				X			
7	X						X	
8			X				X	
9			X				X	
10			⊗			X		Low temperature
11			X				X	
12			X				X	
13	X				X			
14	⊗			X				Self Discharge
15		⊗		X				High Altitude
16		X				⊗		High Altitude
17			X				X	

Programme for Life Test

Charge/Discharge Cycle No.	Type of Charging			54 Minute Rate	Type of Discharging			Remarks
	Normal Charging	Recharging	Direct Charging		5 HR. Rate	Heavy duty 40 Sec. 5 Times	Heavy Duty 40 Sec. 3 Times	
1	2	3	4	5	6	7	8	9
18			X				X	
19			X			X		
20	X				X			
21	⊗			X				Vibration
22		X					X	
23			X				X	
24			X				X	
25			X			X		
26	X				X			
27	X						X	
28			X				X	
29			X				X	
30		⊗		X				High Temperature
31		X					X	
32			X				X	
33			X				X	
34			X				X	
35			X			X		

NOTES

1 Charging, Discharging, Recharging etc, should be carried out as per operating instructions of the batteries.

2 Direct charging is to be carried out with dc source of 28, 5V to 30V with source impedance less than 0·009 Ohms.

3 The tests specified in remarks column should be carried out after carrying out corresponding charge/discharge cycle marked ⊗.

ANNEX D

[*Clause* 10.2.12.4(a)]

Amplitude Vs Frequency Table for Vibration Test

Frequency Hz	**Amplitude** mm	**Frequency** Hz	**Amplitude** mm	**Frequency** Hz	**Amplitude** mm	**Frequency** Hz	**Amplitude** mm
10	5·5	60	0·22	110	0·07	160	0·04
20	1·56	70	0·16	120	0·065	170	0·035
30	0·72	80	0·12	130	0·08	180	0·03
40	0·42	90	0·10	140	0·05	190	0·03
50	0·28	100	0·08	150	0·045	200	0·028

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